GENERAL NOTES.

GEOLOGY AND PALÆONTOLOGY.

On the Glacial Flow in Iowa.—There is evidence of at least three ice-flows, or advances, of the glacial sheet in Iowa:

First, from the northeast; second, from the northwest, as recognized by Dr. C. A. White;[1] and, third, from the north.[2] The evidences of these flows are found in the striated rocks, the transported materials, and the moraines.

The first glacial flow, so far as we have present record of it, was from the northeast to the southwest. Native copper and iron ore have been found in the drift in the extreme northern as well as the extreme southern part of the State, in irregular lumps of a few ounces or a few pounds in weight.

One lump of iron ore, found by E. W. Jacobs, Esq., in the drift, in the northern part of Cerro Gordo County, weighed slightly over six pounds, while lumps of copper from the drift of the western part of Floyd County weighed from three ounces to as many pounds. One lump of copper found in Lucas County[3] weighed upward of thirty pounds; and specimens much smaller have been found in other portions of the State.

These specimens are, in all respects, like the native copper and iron ore from the mines in the Lake Superior region; and hence, as Dr. White observes, they were probably derived from this region.

"On account of the friable nature of a considerable part of the rocks of Iowa, or the facility with which they have become disintegrated, the grooves and the scratches of the glacier which were once doubtless abundant upon them have, to a considerable extent, become obliterated."[4] "For this reason, together with the fact that the drift so generally and deeply covers those surfaces which probably yet preserve such traces, we very seldom have an opportunity to observe them in Iowa."[4]

Nevertheless, the surface of the upper carboniferous limestone on the west side of the Missouri River, opposite Council Bluffs, shows glacial scratches having a direction south, 41° west.[5] These facts seem to imply the existence of a glacial current or flow, during some part of the glacial period, having a southwesterly direction.

[1] White's Geology of Iowa, p. 91.

[2] So far as we have knowledge of, at the present time, this seems to have been the chronological order of the ice-flows within the borders of this State.

[3] White's Geology of Iowa, p. 96. [4] Ibid., p. 93. [5] Ibid., p. 94.

The second glacial current was from the northwest to the southeast. We appear to have sufficient evidence of its direction in the glacial scored rocks, and the boulders found in the drift in different portions of the State.

The direction of the striæ observed upon the Burlington limestone, near Burlington, in the extreme southeastern portion of the State, was south, 22° east.[1]

Up to last year, this was the only locality known in Iowa where the rock surface still preserved unmistakable evidence of a southeasterly flow of the ice. But in September last, while making examinations of the Devonian limestone in the west bank of the Iowa River, at Iowa City, evidence of glacial action was observed, and upon removing the incumbent drift and loess, the surface of the rock was found to be most beautifully planed and scored by glacial action. The size of this surface was ten feet by sixteen feet, and the parallel striæ have the direction south, 73° east. Near the centre of this surface[2] one large groove was about ten feet in length and four feet in average width. As much of this rock has been removed in quarrying, it is impossible to ascertain the exact original extent of this groove. It has a depth, on the south side, of eighteen inches, while the bottom slopes gradually upward to the north; and what is of peculiar interest is the fact that the bottom, and particularly the north side, is beautifully smoothed and striated, while the south side, which is very abrupt, shows scarcely a trace of the smoothing and striating action of the ice. The trend of this groove is north, 69° east. The north side of the groove presents several distinct sets of striæ, the bearings of two of the more prominent of which were taken, with the following results:

First, north, 36½° east; second, north, 40° east, with a slope of 13½° upward. This groove was formed by a portion of the ice which seems to have been deflected from its normal course at this point.

About one hundred and forty yards south of this another surface was uncovered which presented seven or eight distinct sets of striæ. The bearings of five of the principal sets of striæ were taken, with the following results:

No. 1, south, 60° east.
No. 2, south, 85½° east.
No. 3, north, 83½° east.
No. 4, south, 80½° east.
No. 5, north, 71½° east.

The great variation in the direction of the striæ at this point is believed to have been caused by a deflection of the relatively thin ice from its normal course by some local obstruction.

[1] White's Geological Survey of Iowa, p. 94. In these cases no allowance is made for magnetic variation.

[2] The surface is from thirty to forty feet above the water in the Iowa River.

Fifty feet to the south of the above the rock presents an equally beautiful scored surface, having, however, but one set of striæ, with a direction south, 70° east.[1]

In the drift which immediately overlies the rock at this place a boulder of red Sioux quartzite, weighing about one hundred pounds, was found; and on the opposite side of the river another of the same material somewhat larger. Large boulders of the same material have also been found in considerable abundance in the drift for a distance of fifteen miles north from this locality. These boulders are in all respects identical, lithologically, with the red Sioux quartzite exposed in the extreme northwestern corner of the State, and were, without doubt, derived from that region. This evidence, together with the fact that the red Sioux quartzite boulders are found in greater or less abundance in both the western and southern portions of the State,[2] seems conclusive evidence that the ice-flow, at this period of the glacial epoch, had a more easterly direction than has been heretofore supposed.

The evidence of the third, or last, advance of the ice-sheet in Iowa is found in the moraines, which extend nearly across the western portion of the State from north to south. "These may be described as two great loops, one within the other, and with nearly parallel sides."[3]

The *outer moraine* may be approximately located as follows: Beginning a little west of the north line of Osceola County, in the north part of the State, it extends first eastward to Spirit Lake, in the northeast part of Dickinson County; thence south, curving around east of the Little Sioux River, to Storm Lake, in Buena Vista County; thence in a general southeasterly direction to near the northeast corner of Guthrie County; "thence along the Middle and South Raccoon into the north part of Madison County;"[3] thence curving to the east and northeast, "entering Jasper County;" thence to the north, which course is pursued until Clear Lake, in the west part of Cerro Gordo County, is reached; thence to the northeast, cutting across the northwest portion of Worth County, and entering Freeborn County, Minnesota, about midway between its east and west lines.

The *inner moraine* enters Iowa from the northwest, slightly west of Spirit Lake. It passes southeast with, and parallel to, the outer moraine into the western part of Palo Alto County, but instead of curving to the west from that point and continuing parallel with the former, it pursues a southeasterly course

[1] In all the above bearings an allowance of seven degrees is made for the variation of the magnetic needle.

[2] White's Geological Survey of Iowa, vol. i. p. 91.

[3] Prof. J. E. Todd, Iowa Hort. Rept., vol. xviii.

through Pocahontas and Webster Counties to the northwest corner of Boone County; thence eastward to the north-central portion of Story County; thence north into southwest Franklin County, and from that point to the northwest through Wright and Hancock Counties to Forest City, in the southeast part of Winnebago County; thence to the northwest to the northeast corner of Kossuth County; thence curving to the southeast, "forming an interlobular portion to the east side of Winnebago County;"[1] thence uniting with the *outer* moraine, as it cuts across the northwest portion of Worth County, and enters Freeborn County, Minnesota.

"These moraines are linear bends of knobby drift, and structurally are developments of the till, having similar features with it, except that their altitudes are exaggerated."[1] They were formed by an extension or "finger" of the main mass of ice at the north; the one which formed the outer moraine reached a point some distance south of Des Moines, but there stopped in its course by the action of the warm south winds and the sun, which soon caused it to retreat to the north, beyond the limits of the State; but only to again advance at a colder period, but this time with diminished volume, and to be soon driven back again by the winds and the sun.

By the second advance of the ice-sheet the inner moraine was formed.

An extended study of the drift and loess formations of the entire State would doubtless throw much additional light upon the evidence of the ice-flows and the condition of things within the borders of the State during and at the close of the glacial epoch.—*Clement L. Webster, State University, Iowa.*

MINERALOGY AND PETROGRAPHY.[2]

Petrographical News.—Very recently Professor Judd[3] has undertaken to show that his schillerization theory[4] is founded upon well-known facts. In addition to the planes of least cohesion (cleavage planes) and the gliding planes, there is a third series of planes in crystals,—the solution planes, along which the solution of the crystal takes place most readily. These are distinct from either the cleavage or the gliding planes, and their position in the crystal is dependent upon its symmetry. When a crystal fragment is subjected to the action of a solvent, solution begins along these planes, little irregular-shaped hollows appear, and as these grow larger they assume the form of negative crystals. These hollows gradually become filled with secondary substances, and in this way arise the inclusions, which

[1] Prof. J. E. Todd, Iowa Hort. Rept., vol. xviii.
[2] Edited by Dr. W. S. BAYLEY, Madison, Wisconsin.
[3] American Naturalist, Dec. 1885, p. 1216.
[4] Geological Magazine, vii., Dec. 1886, p. 81.